Fall 2004 through Spring 2005

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Root River Steelhead Facility

Fall 2004 and Spring 2005

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Abstract – Fall 2004 saw another dry season in southeast Wisconsin, resulting in a second consecutive weak run of fall fish into the Root River. A total of 378 chinook salmon, 1,259 coho salmon, 1,258 steelhead and 34 brown trout were examined at the Root River Steelhead Facility (RRSF) during fall, 2004 and spring, 2005. There was enough rainfall in late summer to enable capture and transport of 296 broodstock skamania steelhead to the Kettle Moraine Springs Hatchery. All of the chinook captured were passed upstream. The RRSF serves as backup egg-take facility for coho salmon stocked into the Wisconsin waters of Lake Michigan and due to the low water situation we fell slightly short of the 1.5 million egg goal. Just over 500,000 coho eggs were obtained at RRSF, and 891,000 were obtained from the Besadny Anadromous Fish Facility (BAFF) in Kewaunee, WI. The remainder was contributed by the state of Michigan. As a result, WDNR was able to meet coho production needs for Lake Michigan. The spring 2005 return of 885 steelhead replaced last spring as the third lowest since 1994. The majority of the spring steelhead (93%) were passed upstream. Three hundred twelve were spawned, while another 60 were sacrificed for health assessment after spawning. The 312 spring spawners produced 774,000 eggs and the Besadny Facility contributed 256,000 eggs to meet our spring steelhead goal. Currently, 165,000 skamania steelhead are in production for the 2006 skamania stocking. All 34 brown trout captured were passed upstream. The estimated population of chinook salmon above the weir was 416 (± 40 SD). Population estimates for the other species were brown trout: 280 (± 188 SD), coho salmon: 2,870 (± 1,284 SD), fall steelhead: 96 (± 19 SD). Spring population estimates were chambers creek steelhead: 261 (± 40 SD), and ganaraska steelhead: 499 (± 89 SD).

The Root River Steelhead Facility (RRSF) is one of three weirs operated by Wisconsin Department of Natural Resources (WDNR) to collect information and broodstock from Lake Michigan trout and salmon. The Strawberry Creek Weir in Sturgeon Bay targets chinook salmon, while the Besadny Area Fishery Facility (BAFF) on the Kewaunee River targets coho salmon and steelhead and the RRSF contributes primarily steelhead and coho. In addition, BAFF and RRSF function as backup collection sites for the other species. Brown trout do not return well to the weir sites, and are collected in the lower reaches of the rivers with a boat electroshocker. Management of trout and salmon in Lake Michigan brood rivers is intended to ensure adequate egg collections, conserve the genetic diversity of feral trout and salmon stocks and provide fishing opportunities. To accomplish these objectives, weir operations follow strategies outlined by WDNR guiding documents (e.g., Ives 1996, WDNR 1999).

The weirs provide a more efficient and reliable method to collect adult salmonids than the portable weirs and electrofishing efforts employed during past years. The RRSF was constructed in 1994 through a cooperative effort by WDNR, Salmon Unlimited, City of Racine and U.S. Fish & Wildlife Service. In addition to providing a collection and processing site for returning adult salmonids, the RRSF provides a unique educational tool for school groups and other interested publics.

This paper reports the results of data collected at the RRSF during fall, 2004 and spring, 2005. These data contribute to a long-term index of chinook, coho and steelhead populations in the Root River, and are collected to fulfill three objectives: 1) track the abundance of salmonid returns, 2) measure growth and condition of each species and/or strain, and 3) estimate return rate of each species.

METHODS

During operation of the weir, a minimum of 100 fish per targeted species and fin clip were sampled, except that data on skamania broodstock were obtained from Kettle Moraine Springs Hatchery (KMSH). Skamania, which spawn in late winter, are transported to the hatchery where they are allowed to mature in holding ponds. These fish are handled only minimally at the weir to minimize stress. Sampled fish were measured to the nearest millimeter, weighed to the nearest 0.1 pound, examined for fin clips, gender and condition. The remaining fish were tallied by species, gender and fin clip. Gametes were stripped from these fish, if needed. After this initial handling, fish were either passed upstream or sacrificed (fish health or contaminant samples). All fish passed upstream were given an upper caudal clip for population estimates.

All non-target species or fin clips were tallied by species, fin clip and sex, given an upper caudal clip and passed upstream. All coded wire tagged (CWT) fish are marked by an adipose-only clip, and have a tiny microtag implanted in their heads. The CWT fish were measured, weighed and sacrificed; heads were removed from behind the opercular flap, and frozen for later examination. Fish were collected as needed for other studies including disease or contaminant samples.

Size and condition

Trends in size and condition of all species processed at RRSF are calculated. Only fish with both total length and weight data are included in calculations of average, standard and trophy weight (95^{th} percentile of the weight distribution), and standard weight (predicted weight at a given length based on a length-weight regression). The lengths used for calculation of standard weight are: 30 inches for chinook, 22 inches for coho, 22 inches for steelhead, and 20 inches for brown trout.

Coho salmon growth, age and maturity evaluation

Work continues on the growth, age and maturity study of coho salmon. In order to reach the vision of a Healthy Great Lakes Ecosystem described in the Strategic Vision of the Great Lakes Fishery Commission for the Decade of the 1990s and to more quickly detect changes in the forage base in Lake Michigan, accurate coho salmon data by age is needed. Unlike other salmon and trout that mature in 2-4 years and then return to spawning facilities, coho salmon only spend two summers in the lake prior to returning to their stocking stream. This study will allow Wisconsin to build a database on growth and maturity by age of coho salmon stocked in the Root River. This data will help fisheries biologists around the lake refine stocking models, growth parameters, forage trends and survival and mortality rates of coho salmon. Coho salmon marked as part of this study are expected to imprint on the Root River and home to the Root River when they mature and attempt to spawn. Most mature at age 2+, with a few showing up at age 1+.

Adipose fin-clipped, uniquely coded wire tagged (CWT) coho are collected at RRSF as part of fall spawning/harvesting operations. Adipose clipped/CWT coho salmon will also be collected through the WDNR contact creel survey, by other states, and during other WDNR surveys, but the primary collection technique will be at RRSF.

During spawning operations at RRSF, coho salmon with an adipose fin clip are marked with a uniquely numbered jaw tag, weighed, and measured. Heads from all jaw tagged coho salmon will be collected and transported to the WDNR Milwaukee Office for storage and processing. During the winter months, coho salmon heads collected at RRSF and from other sources will be checked for CWTs. Coho salmon heads with a CWT detected will be dissected for CWT recovery. Extracted CWTs will be decoded and the data entered into the database for subsequent trend analysis.

Steelhead strain evaluation

Steelhead stocking targets in the Root River were 35,000 per strain until 1999, when chambers creek and ganaraska targets were reduced to 27,000. All steelhead stocked in the broodstock rivers (Root and Kewaunee Rivers) are marked with a fin clip to identify the strain and yearclass. Each strain is assigned three fin clips (two fin clips prior to 1997), which are rotated annually. The three clips allow much cleaner separation of year-classes than the two-year clip rotation used previously. In addition to their use in identifying fish for breeding purposes, the fin clips allow each strain to be evaluated. This includes age of returning fish, return rates and population estimates by strain.

Population estimates

Fish that are passed by the weir are marked with a caudal (tail) clip, and recaptures of marked fish are noted in the creel survey for a mark-recapture population estimate of the population above the weir. Population estimates for each species or strain are derived from one of two equations. When sample sizes were adequate, the Petersen equation for mark and recapture was used (Ricker 1975):

$$N = \frac{M * C}{R} \quad (1)$$

Where

N = size of population in the river
M = number of marked fish at large in the river
C = number of recaptured fish
R = number of marked fish in the recapture sample

The sample standard deviation was calculated as:

$$S(N) = \sqrt{\frac{M^2 * C * (C - R)}{R^3}} \quad (2)$$

For species or strains with low sample sizes (i.e., 3 or fewer marked recaptures), the Bailey's modified equation was used for the population estimate (Ricker 1975):

$$N = \frac{M * (C + 1)}{R + 1} \quad (3)$$

With sample standard deviation:

$$S(N) = \sqrt{\frac{M^2 * (C + 1) * (C - R)}{(R + 1)^2 * (R + 2)}} \quad (4)$$

RESULTS AND DISCUSSION

The ninth season of operation for RRSF began October 27, 2004 and concluded April 21, 2005. A total of 378 chinook, 1,259 coho, 1,286 steelhead and 34 brown trout were examined (Table 1).

Chinook salmon

A total of 378 chinook salmon were examined at RRSF during fall, 2004 (Table 2). Eggs for hatchery production were taken at Strawberry Creek near Sturgeon Bay (see Peeters and Royseck 2004). All of the chinook captured were passed upstream. Poor water levels resulted in a very low number of fish. Although the sample size was low, analysis of length-weight data revealed the average length (26.9 inches) and weight (7.9 pounds) of returning chinook was down considerably. Hopefully the fall 2005 run will be strong and provide statstically stronger length-weight numbers.

Coho salmon

A total of 1,259 coho salmon were examined at RRSF (Table 4). Most (91%) were passed upstream. Sixty-six were sacrificed for coded wire tags, 30 for health assessments and 15 for contaminant analysis. About 556,000 eggs were taken from 519 coho at the weir. The age composition (based on length-frequencies) indicated that the run was comprised of 16% age 1+ and 84% age 2+ coho salmon (Table 5). Average coho length (25.6 inches) and weight (5.7 pounds) continue to be down compared to 1999-2001, although slightly better than the previous two years. (Table 3).

Steelhead

Steelhead returns to the weir continued to decline. A total of 1,258 steelhead were examined at RRSF from October 27, 2004 to April 21, 2005. Most fish (896 or 71%) were passed upstream (Table 6). Sixty steelhead were sacrificed for disease testing and five were sacrificed for contaminant testing. In addition, 296 skamania-strain steelhead were transported as broodstock to KMSH during late summer and fall. Skamania egg collection totaled 254,000. Egg collection totals for the other two strains were 344,000 and 430,000 chambers creek and ganaraska, respectively.

During most years, age 3 and 4 fish contribute the bulk of the steelhead run, and this trend continued for fall 2004/spring 2005 (Table 8). Age 5 fish were also well represented in the spring. Steelhead return rates to the weir prior to 1997, fall and spring combined, averaged slightly over 2% for year-classes followed through age 7. Although not enough time has passed to follow the year-classes after 1997 to completion, it appears that the trend is toward considerably weaker year-classes with the exception of the 1998 year-class (Table 7). Each year the 1998 year-class has been strongly represented in the returning population.

Management actions to address the decline in steelhead broodstock that have been implemented include: increased weir operations, collection of additional broodstock by electroshocking when shortfalls are projected, inoculation of adult skamania against disease, and addition of skamania gametes from other sources to increase genetic diversity. A reduction in angler bag limits either below the weirs or in all Wisconsin waters of Lake Michigan was considered, but was postponed in the hope that other actions will be sufficient.

Steelhead strain evaluation

The percent age composition of the spawning runs was assigned from age-length keys developed from 125 known age finclipped fall fish and 490 known age finclipped spring fish. Age 1 fish were not represented in the fall sample, age 2 were 0.8%, 3 were 41.6%, 4 were 52.3%, 5 were 0.8%, 6 were 4.0% (the 1998 year-class) and 7 were 1.1%. During spring, age 2 represented 14.7% of the return, 3 were 15.3%, 4 were 54.5%, 5 were 14.5%, 6 were 0.6% and 7 were 0.4% (Table 8). As in past years, the return of skamania from the 1998 year class was strong, making the 1998 year class return rate the highest (1.22%) since the 1993 year class. The 1999 year class of all three strains was again poorly represented. The good news is that the 2000 year class for all three strains continued to be strong.

Fall skamania tend to have higher average length and weight than spring steelhead of the same age, but are comparable to spring fish one year older (Tables 9, 10, 11, Figures 1, 2). This is probably because a given-age fish in fall will be classified one year older the following spring, but puts on little growth during the winter months. Chambers creek steelhead averaged slightly longer and heavier than ganaraska, especially at younger ages. This could be due to either higher growth rates for chambers creek, or perhaps only relatively large chambers creek steelhead make a spawning run.

Population estimates

The number of chinook handled at the weir during 2004 was 378 (Table 1), and the population estimate was 416 (± 40 SD)(Table 12). With slightly increased water flow as the fall progressed coho run improved with an estimate of 2,870 (± 1,284 SD). Skamania steelhead returns remain low. All of the fall steelhead encountered at the weir were skamania strain. If the fall steelhead population (estimated at 96 ± 19 SD) is combined with 296 removed to KMS hatchery, then about 392 skamania returned during fall, 2004, one of the lowest estimated return of skamania on record continuing the trend of poor skamania steelhead return rates. Chambers creek were estimated at 261 (+ 40 SD), while the ganaraska estimate was 499 (+ 89 SD).

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Table 1. Summary of chinook salmon, coho salmon, steelhead and brown trout captured at the Root River Steelhead Facility during 1996 to 2005.

CHINOOK SALMON

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1996	62	5,440	87	5,589
Fall, 1997	0	3,974	128	4,102
Fall, 1998	67	3,845	65	3,977
Fall, 1999	221	5,381	420	6,022
Spring, 2000	0	7	0	7
Fall, 2000	244	6,965	166	7,375
Fall, 2001	432	9,697	84	10,213
Spring, 2002	0	1	0	1
Fall, 2002	308	9,912	120	10,340
Fall 2003	0	149	0	149
Fall 2004	0	378	0	378

COHO SALMON

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1996	161	3,940	305	4,406
Fall, 1997	655	6,909	330	7,894
Fall, 1998	328	3,336	336	4,000
Fall, 1999	154	978	18	1,150
Fall, 2000	472	2,921	15	3,408
Fall, 2001	314	942	71	1,327
Fall, 2002	221	2,076	217	2,514
Fall 2003	0	126	72	198
Fall 2004	0	1,148	111	1,259

STEELHEAD

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1996	248	105	0	353
Spring, 1997	2	2,918	125	3,045
Fall, 1997	408	228	8	644
Spring, 1998	0	382	0	382
Fall, 1998	86	64	1	151
Spring, 1999	0	2,131	132	2,263
Fall, 1999	50	19	1	70
Spring, 2000	0	2,107	64	2,171
Fall, 2000	160	59	0	219
Spring, 2001	63	790	6	859
Fall, 2001	314	176	0	490
Spring, 2002	0	1,180	123	1,303
Fall, 2002	253	48	0	301
Spring, 2003	0	977	83	1,060
Fall, 2003	252	6	0	258
Spring, 2004	0	966	62	1,028
Fall, 2004	296	77	0	373
Spring, 2005	1	819	65	885

BROWN TROUT

Harvest year	Harvested	Passed upstream	Misc. samples	Total
Fall, 1997	114	369	3	486
Spring, 1998	0	2	0	2
Fall, 1998	14	202	12	228
Fall, 1999	0	125	0	125
Spring, 2000	0	6	0	6
Fall, 2000	2	241	0	243
Spring, 2001	0	2	0	2
Fall, 2001	1	176	0	177
Fall, 2002	3	291	0	294
Spring, 2003	0	1	0	1
Fall, 2003	0	53	0	53
Spring, 2004	0	3	0	3
Fall, 2004	0	28	0	28
Spring, 2005	0	6	0	6

Table 2. Number of chinook salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 2004.

Date	Number harvested	Number passed upstream	Number of miscellaneous samples	Total number of fish
10-Oct-2004	0	260	0	260
02-Nov-2004	0	65	0	65
09-Nov-2004	0	52	0	52
Totals	0	377	0	377

Table 3. Average weight, average length, standard weight and trophy (95th percentile) weight for the major salmonid species returning to the Root River Steelhead Facility during 1994 to 2005.

Season	Number used in analysis	Average weight (pounds)	Average length (inches)	Standard weight	Trophy weight
CHINOOK SALMON					
1994 – 95	343	8.9 ± 5.3	27.7 ± 5.6	9.7	17.8
1995 – 96	443	12.0 ± 5.9	30.7 ± 5.2	10.1	21.0
1996 – 97	703	11.7 ± 5.7	30.7 ± 5.4	9.8	21.1
1997 – 98	490	12.7 ± 4.9	32.5 ± 4.4	9.5	21.1
1998 – 99	389	12.2 ± 5.0	31.9 ± 4.3	9.5	19.6
1999 – 2000	418	13.2 ± 4.4	32.5 ± 3.8	9.9	19.9
2000 – 01	536	12.3 ± 5.7	31.1 ± 5.7	9.7	20.0
2001 – 02	672	15.7 ± 5.2	34.3 ± 4.3	10.3	23.5
2002 – 03	538	13.3 ± 4.8	32.8 ± 4.7	9.4	19.9
2003 – 04	-	-	-	-	-
2004 – 05	100	7.9 ± 5.2	26.9 ± 6.3	9.0	16.2
COHO SALMON					
1994 – 95	208	1.5 ± 1.1	15.9 ± 2.5	3.7	3.0
1995 – 96	594	3.1 ± 2.5	19.6 ± 5.1	3.6	9.0
1996 – 97	1,273	5.1 ± 2.4	23.9 ± 4.7	3.5	8.3
1997 – 98	828	3.8 ± 1.7	21.8 ± 3.5	3.5	6.7
1998 – 99	477	4.3 ± 1.7	23.4 ± 3.1	3.4	7.5
1999 – 2000	338	7.1 ± 4.4	25.5 ± 5.9	4.0	13.5
2000 – 01	472	8.2 ± 2.5	27.3 ± 3.2	3.9	11.6
2001 – 02	316	6.8 ± 2.9	25.9 ± 4.9	3.7	10.3
2002 – 03	445	4.8 ± 1.7	23.8 ± 3.0	3.5	7.6
2003 – 04	93	5.1 ± 2.3	23.9 ± 4.7	3.7	8.2
2004 – 05	383	5.7 ± 2.1	25.6 ± 3.5	3.4	9.2
STEELHEAD					
1994 – 95	638	5.9 ± 2.8	25.4 ± 4.7	3.5	10.7
1995 – 96	963	6.2 ± 2.7	25.6 ± 4.3	3.7	11.0
1996 – 97	626	7.2 ± 2.4	27.4 ± 3.3	3.6	11.2
1997 – 98	522	5.8 ± 2.9	25.7 ± 4.9	3.4	11.2
1998 – 99	603	6.2 ± 2.0	25.9 ± 3.3	3.9	9.8
1999 – 2000	766	7.3 ± 2.5	27.2 ± 3.9	3.6	11.0
2000 – 01	482	5.0 ± 1.7	24.1 ± 2.7	3.7	8.4
2001 – 02	674	6.9 ± 2.4	26.9 ± 3.7	3.6	10.5
2002 – 03	526	5.3 ± 2.3	24.5 ± 4.1	3.6	9.4
2003 – 04	576	6.7± 2.1	26.7 ± 3.2	4.0	10.5
2004 – 05	764	5.9 ± 2.3	25.6 ± 4.0	3.6	9.5
BROWN TROUT					
1994 – 95	108	4.9 ± 1.5	22.1 ± 2.7	3.4	7.0
1995 – 96	201	5.3 ± 2.2	22.4 ± 3.3	3.6	9.0
1996 – 97	162	4.6 ± 2.1	21.4 ± 4.0	3.4	7.8
1997 – 98	250	6.7 ± 3.4	24.0 ± 3.7	3.8	14.1
1998 – 99	55	6.6 ± 3.2	24.3 ± 3.5	3.5	13.5
1999 – 2000	120	6.7 ± 2.6	23.9 ± 3.7	3.5	10.1
2000 – 01	0				
2001 – 02	95	5.2 ± 1.8	21.9 ± 3.1	3.7	8.2
2002 – 03	156	5.5 ± 1.6	22.5 ± 2.2	4.0	8.0
2003 – 04	44	6.3 ± 2.4	23.6 ± 2.6	4.0	11.7
2004 – 05	30	7.5 ± 3.0	25.3 ± 3.6	4.1	13.8

Table 4. Number of coho salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 2004.

Date	Number Harvested	Number passed upstream	Number of miscellaneous samples	Total Number of fish
27-Oct-2004	0	325	40	365
02-Nov-2004	0	588	62	650
09-Nov-2004	0	235	9	244
Totals	0	1,148	111	1,259

Table 5. Estimated age composition of coho salmon (sexes combined) examined at the Root River Steelhead Facility during fall, 1994 through 2004. During 1994 to 1998, age was based on age-length key developed from known-age fin-clipped coho salmon. After 1998, ages were assigned by length-frequency of measured fish.

Year of Return	Percent age composition 1+	2+	Number used in analysis	Total return
1994	53 %	47 %	485	813
1995	24 %	76 %	1,349	3,321
1996	32 %	68 %	4,170	4,406
1997	5 %	95 %	6,978	7,894
1998	12 %	88 %	2,439	4,000
1999	44 %	56 %	341	1,150
2000	7 %	93 %	472	3,408
2001	16 %	84 %	320	1,327
2002	16%	84%	334	2,514
2003	17%	83%	93	198
2004	17%	83%	363	1,259

Table 6. Number of steelhead harvested, passed upstream and sampled at the Root River Steelhead Facility during fall, 2004 and spring, 2005.

Date	Number Harvested	Number Passed Upstream	Number of miscellaneous samples	Total Number of fish
27-Oct-2004	0	8	0	8
02-Nov-2004	0	33	0	33
09-Nov-2004	0	36	0	36
01-Dec-2004	296	0	0	296
31-Mar-2005	0	287	0	287
06-Apr-2005	0	325	30	355
14-Apr-2005	0	181	30	211
21-Apr-2005	1	26	5	32
Totals	297	896	65	1,258

Table 7. Return rate of steelhead to the Root River Weir during 1994 through 2005. Number at age were estimated by expanding the proportion at each age in the aged sample against the return of known-strain steelhead. Fall data include only skamania; spring data combine chambers creek and ganaraska returns.

year	number	return	Number at age								Return
class	stocked	time	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total	Rate
1993	30,417	fall	70	59	125	417	22	4	19	716	2.35%
	69,883	spring	0	222	983	1024	17	0	0	2246	3.21%
	100,300	**total**	**70**	**282**	**1108**	**1440**	**39**	**4**	**19**	**2962**	**2.95%**
1994	37,347	fall	76	78	87	37	3	14	10	306	0.82%
	72,313	spring	0	299	534	116	133	45	1	1129	1.56%
	109,660	**total**	**76**	**377**	**621**	**154**	**136**	**59**	**12**	**1435**	**1.31%**
1995	34,254	fall	0	27	25	31	12	39	43	178	0.52%
	69,983	spring	0	25	111	807	216	19	21	1199	1.71%
	104,237	**total**	**0**	**52**	**136**	**838**	**228**	**59**	**64**	**1377**	**1.32%**
1996	35,262	fall	0	0	18	84	20	8	3	133	0.38%
	70,225	spring	0	47	850	815	10	9	0	1731	2.47%
	105,487	**total**	**0**	**47**	**868**	**899**	**30**	**17**	**3**	**1864**	**1.73%**
1997	37,484	fall	0	0	46	5	5	2	0	58	0.15%
	66,735	spring	0	38	323	61	18	6	8	455	0.68%
	104,219	**total**	**0**	**38**	**369**	**66**	**23**	**8**	**8**	**513**	**0.49%**
1998	35,528	fall	0	5	231	156	30	10	-	432	1.22%
	53,914	spring	0	122	578	723	146	19	3	1591	3.0%
	89,442	**total**	**0**	**127**	**809**	**879**	**176**	**29**	**3**	**2023**	**2.3%**
1999	37,010	fall	0	5	77	41	2	-		125	0.33%
	54,405	spring	0	25	245	107	15	4		396	0.73%
	91,415	**total**	**0**	**30**	**322**	**148**	**17**	**4**		**521**	**0.57%**
2000	35,247	fall	8	0	154	130	-			292	0.82%
	54,160	spring	0	42	403	444	100			989	1.83%
	89,407	**total**	**8**	**42**	**557**	**574**	**100**			**1281**	**1.43%**
2001	33,634	fall	0	38	103	-				141	0.42%
	54,189	spring	0	100	323	376				799	1.47%
	87,823	**total**	**0**	**138**	**426**	**376**				**940**	**1.07%**
2002	35,448	fall	0	2	-					2	0.01%
	54,273	spring	0	12	106					118	0.22%
	89,721	**total**	**0**	**14**	**106**					**120**	**0.13%**
2003	35,145	fall	0	**-**						0	0%
	58,920	spring	0	101						101	0.17%
	94,065	**total**	**0**	**101**						**101**	**0.11%**

Table 8. Estimated age composition of steelhead (sexes combined) examined at the Root River Steelhead Facility during 1994 – 2005. Age is based on age-length key developed from known-age fin clipped steelhead. Total number represents the number of steelhead used in the analysis. During 2000 - 2004, data from skamania transported to Kettle Moraine Springs Hatchery are included.

Year of return	Percent age composition							Total Number
	1+	2+	3+	4+	5+	6+	7+	
Fall – 1994	8.9	7.5	43.2	34.2	6.2	-	-	146
Spring – 1995		7.3	31.3	38.0	12.7	10.7	-	450
Fall – 1995	15.6	12.2	21.8	49.7	0.7	-	-	147
Spring – 1996		11.0	36.1	33.1	9.1	10.1	0.6	692
Fall – 1996	-	26.3	36.8	5.3	31.6	-	-	21
Spring – 1997		1.0	22.1	42.5	22.5	10.5	1.4	483
Fall – 1997	-	4.4	14.2	67.2	9.6	4.4	-	135
Spring – 1998		15.3	35.9	37.6	5.6	5.2	0.4	287
Fall – 1998	-	-	29.3	44.0	25.3	1.4	-	75
Spring – 1999		2.1	46.5	44.2	7.3	-	-	385
Fall – 1999	-	-	32.3	54.7	5.2	7.8	-	51
Spring – 2000		8.0	21.3	53.6	14.2	3.0	-	714
Fall – 2000	-	2.7	25.3	46.7	6.7	8.0	10.7	75
Spring – 2001		3.5	83.2	8.9	1.4	2.8	0.2	482
Fall – 2001	2.4	1.4	72.8	1.5	13.3	26.3	7.0	212
Spring – 2002		4.2	23.2	68.3	1.5	0.8	2.0	575
Fall – 2002	-	-	26.8	53.9	1.7	2.7	14.8	278
Spring – 2003	-	13.1	52.9	14.1	19.2	0.8	-	491
Fall – 2003	-	14.1	57.6	15.3	11.1	0.8	1.1	262
Spring – 2004	-	1.5	39.2	54.0	1.8	2.3	1.0	385
Fall – 2004	-	0.8	41.6	52.8	0.8	4.0	-	125
Spring – 2005	-	14.7	15.3	54.5	14.5	0.6	0.4	490

Table 9. Average length and weight at age (± 1 SD) of fall-run skamania-strain steelhead at the Root River Steelhead Facility during 1994 to 2004. Data from 2000 - 2004 were taken from fish transported and held at Kettle Moraine Springs Hatchery, so some weight loss likely occurred.

Season	Strain	Age 2+	Age 3+	Age 4+	Age 5+	Age 6+	Age 7+
Fall, 1994	Skamania	23.6 (± 0) 4.5 (± 0) N = 1	26.1 (± 1.8) 5.6 (± 1.1) N = 52 / 43	29.9 (± 1.8) 8.3 (± 1.5) len N = 40 wt N = 31	31.9 (± 2.7) 10.2 (± 2.2) len N = 13 wt N = 12	33.6 (± 1.0) 11.6 (± 1.3) N = 11	
Fall, 1995	Skamania	25.8 (± 1.0) 5.3 (± 0.8) N = 14	27.0 (± 1.5) 6.2 (± 1.1) N = 27	30.5 (± 2.0) 9.1 (± 2.1) N = 70	31.7 (± 1.1) 10.5 (± 1.4) N = 6		
Fall, 1996	Skamania	22.1 (± 0) 4.0 (± 0) N = 1	27.2 (± 1.4) 6.7 (± 0.7) N = 7	28.8 (± 0) 8.0 (± 0) N = 1	32.1 (± 1.7) 10.1 (± 1.8) N = 2		
Fall, 1997	Skamania	28.5 (± 1.0) 7.1 (± 0.9) N = 6	27.1 (± 1.1) 6.0 (± 1.0) len N = 19 wt N = 18	31.1 (± 1.8) 9.1 (± 1.9) N = 91	32.1 (± 1.3) 9.6 (± 1.1) N = 12	34.5 (± 1.7) 12.3 (± 3.3) N = 7	36.0 (± 0) 12.9 (± 0) N = 1
Fall, 1998	Skamania		25.8 (± 1.4) 5.1 (± 0.8) N = 22	30.0 (± 2.1) 8.0 (± 1.6) N = 44	31.9 (± 2.0) 9.5 (± 1.5) N = 19		
Fall, 1999	Skamania		28.3 (± 1.6) 7.3 (± 0.8) N = 14	29.0 (± 1.2) 8.0 (± 1.1) N = 25	31.6 (± 2.1) 10.6 (± 0.4) N = 2	32.2 (± 0.6) 10.0 (± 1.1) N = 4	
Fall, 2000	Skamania	26.4 (± 0) 7.0 (± 1.4) N = 2	27.8 (± 1.2) 7.5 (± 1.0) N = 19	30.2 (± 2.0) 8.5 (± 2.0) len N = 37 wt N = 38	28.9 (± 0.5) 8.6 (± 1.0) N = 8	31.2 (± 1.0) 10.6 (± 1.8) N = 6	32.3 (± 2.3) 10.1 (± 1.8) N = 8
Fall, 2001	Skamania		27.0 (± 1.3) 6.8 (± 1.1) len N = 135 wt N = 53	25.5 (± 0.6) 6.6 (± 0.2) len N = 3 wt N = 2	31.5 (± 1.4) 9.3 (± 1.5) len N = 5 wt N = 3	30.5 (± 1.1) 10.1 (± 1.9) len N = 15 wt N = 10	32.6 (± 1.6) 10.9 (± 1.3) len N = 7 wt N = 5
Fall, 2002	Skamania		26.6 (±1.4) 6.2 (± 1.4) len N = 69 wt N = 11	28.7 (± 1.6) 8.0 (± 1.3) len N = 132 wt N = 41	30.0 (± 0.9) 7.3 len N = 4 wt N = 1	30.3 (± 0.7) 7.8 (± 1.1) len N = 6 wt N = 2	32.2 (± 0.9) 10.4 (± 1.1) len N = 31 wt N = 8
Fall, 2003	Skamania	25.4 (± 1.6) 6.3 (± 1.7) N = 10	26.1 (± 1.9) 6.4 (± 1.2) N = 66	29.5 (± 1.4) 8.6 (± 1.0) N = 16	32.1 (±) 2.4 10.9 (± 1.8) N = 17	30.7 7.5 N = 1	
Fall, 2004	Skamania	24.0 (± 0) 4.4 (± 0) N=1	26.3 (± 2.1) 6.2 (± 1.3) N=52	29.2 (± 1.7) 7.9 (± 1.5) N=66	31.8 (± 0) 10.1 (± 0) N=1	32.5 (± 2.6) 10.0 (± 1.6) N=5	

Table 10. Average length and weight at age (± 1 SD) of spring-run chambers creek-strain steelhead at the Root River Steelhead Facility during 1995 to 2005.

Season	Strain	Age 2+	Age 3+	Age 4+	Age 5+	Age 6+	Age 7+
Spring, 1995	Chambers Cr.	20.9 (± 1.1)	23.9 (± 1.7)	28.1 (± 1.4)	28.5 (± 1.4)	31.3 (± 0.9)	
		4.2 (± 1.1)	4.6 (± 1.1)	7.6 (± 1.2)	7.8 (± 1.3)	10.0 (± 1.1)	
		N = 3	N = 73	N = 89	N = 32	N = 25	
Spring, 1996	Chambers Cr.	18.5 (± 0.8)	25.2 (± 1.4)	27.9 (± 1.4)	29.5 (± 1.8)	31.2 (± 1.3)	32.0 (± 0.6)
		2.2 (± 0.3)	5.6 (± 1.1)	7.4 (± 1.2)	9.3 (± 1.6)	10.5 (± 1.5)	12.0 (± 0.7)
		N = 22	N = 87	N = 90	N = 52	N = 41	N = 3
Spring, 1997	Chambers Cr.		24.8 (± 1.3)	28.6 (± 1.9)	27.4 (± 1.6)	32.2(± 1.1)	
			5.3 (± 1.0)	8.3 (± 1.5)	6.6 (± 1.5)	11.2 (± 1.6)	
			N = 33	N = 77	N = 70	N = 35	
Spring, 1998	Chambers Cr.		23.8 (± 1.4)	27.7 (± 2.3)	28.9 (± 1.8)	32.1 (± 0.8)	
			4.3 (± 0.8)	7.0 (± 2.0)	7.5 (± 1.2)	10.2 (± 1.3)	
			N = 42	N = 39	N = 5	N = 7	
Spring, 1999	Chambers Cr.	18.6 (± 0.4)	23.8 (± 1.6)	28.3 (± 2.0)	28.6 (± 2.3)		
		2.7 (± 0.8)	4.7 (± 0.8)	7.6 (± 1.3)	8.0 (± 1.8)		
		N = 2	N = 13	N = 96	N = 4		
Spring, 2000	Chambers Cr.	17.2 (± 1.1)	26.2 (± 1.8)	29.3 (± 1.8)	29.8 (± 2.2)	30.3 (± 1.5)	
		1.6 (± 0.3)	6.3 (± 1.1)	8.3 (± 1.4)	8.7 (± 1.8)	8.6 (± 1.9)	
		N = 12	N = 26	N =90	N = 54	N = 8	
Spring, 2001	Chambers Cr.		23.9 (± 1.6)	27.5 (± 3.3)	31.3 (± 0)	27.8 (± 0.4)	
			4.7 (± 0.8)	6.9 (± 2.0)	10.7 (± 0)	7.1 (± 0.5)	
			N = 62	N = 8	N = 1	N = 4	
Spring, 2002	Chambers Cr.		25.5 (± 1.8)	28.9 (± 1.8)	30.3 (± 2.4)	29.9 (± 2.3)	32.3 (± 1.3)
			5.4 (± 1.1)	8.0 (± 1.6)	9.8 (± 1.4)	8.7 (± 1.6)	11.2 (± 1.8)
			N = 17	N = 206	N = 2	N = 2	N = 8
Spring, 2003	Chambers Cr.	16.9 (±1.4)	24.8 (± 1.3)	28.2 (± 1.5)	28.8 (± 2.2)	28.6 (± .7)	
		1.8 (± .4)	5.1 (± 1.0)	7.4 (± 1.3)	7.7 (± 1.5)	7.1 (± .4)	
		N =20	N =72	N = 27	N = 19	N = 2	
Spring, 2004	Chambers Cr.	16.5 (± 1.8)	24.8 (± 1.4)	28.6 (± 1.8)		31.1 (± 1.6)	32.6 (± .7)
		1.6 (± .4)	5.4 (± .9)	7.9 (± 1.5)		9.7 (± 1.4)	11.0 (± .7)
		N = 3	N = 48	N = 112		N = 5	N = 4
Spring, 2005	Chambers Cr.	17.7 (± 1.2)	24.3 (± 1.1)	27.6 (± 1.9)	29.2 (± 2.2)	28.9 (± 1.7)	
		1.9 (± .3)	4.9 (± .8)	7.1 (± 1.6)	8.1 (± 1.9)	7.8 (± .7)	
		N = 6	N = 38	N = 81	N = 21	N = 3	

Table 11. Average length and weight at age (± 1 SD) of spring-run ganaraska-strain steelhead at the Root River Steelhead Facility during 1995 to 2005.

Season	Strain	Age 2+	Age 3+	Age 4+	Age 5+	Age 6+	Age 7+
Spring, 1995	Ganaraska	16.5 (± 1.3) 1.5 (± 0.5) N = 30	21.5 (± 2.3) 3.3 (± 1.0) len N = 68 wt N = 67	24.2 (± 2.2) 5.0 (± 1.4) N = 81	27.5 (± 1.7) 7.2 (± 2.0) N = 24	28.8 (± 1.2) 8.0 (± 1.4) N = 23	32.5 (± 0) 12.5 (± 0) N = 1
Spring, 1996	Ganaraska	16.6 (± 1.9) 1.7 (± 0.5) N = 57	23.5 (± 1.8) 4.7 (± 1.2) N = 167	25.1 (± 2.0) 5.7 (± 1.4) N = 113	26.7(± 1.9) 7.1 (± 1.5) N = 22	28.6 (± 1.5) 8.7 (± 1.5) N = 29	32.2 (± 0) 12.5 (± 0) N = 1
Spring, 1997	Ganaraska	15.1 (± 1.9) 1.2 (± 0.4) N = 3	23.5 (± 2.1) 4.3 (± 1.3) N = 75	28.4 (± 1.9) 7.9 (± 1.6) N = 125	27.7 (± 2.1) 7.4 (± 1.7) N = 30	27.1 (± 0) 6.7 (± 0) N = 1	
Spring, 1998	Ganaraska	16.7 (± 1.3) 1.6 (± 0.3) N = 45	21.4 (± 1.9) 3.3 (± 0.8) N = 66	25.1 (± 2.6) 5.2 (± 1.5) N = 94	27.0 (± 0.8) 5.9 (± 0.6) N = 7	31.2 (± 0.2) 9.3 (± 0.7) N = 3	30.4 (± 0) 4.9 (± 0) N = 1
Spring, 1999	Ganaraska	17.1 (± 1.6) 2.0 (± 0.6) N = 6	23.7 (± 1.4) 4.9 (± 0.9) N = 167	26.2 (± 1.7) 6.6 (± 1.3) N = 79	27.6 (± 2.0) 7.4 (± 1.8) N = 25		
Spring, 2000	Ganaraska	16.8 (± 1.6) 1.6 (± 0.4) N = 37	25.1 (± 2.2) 5.8 (± 1.6) N = 73	28.6 (± 2.1) 8.3 (± 1.9) N = 202	28.3 (± 2.3) 8.2 (± 2.1) N = 18	29.4 (± 1.7) 9.0 (± 1.1) N = 5	
Spring, 2001	Ganaraska	16.9 (± 0.6) 1.6 (± 0.3) N = 14	23.7 (± 1.5) 4.7 (± 0.8) N = 273	27.1 (± 2.4) 7.0 (± 2.1) N = 18	29.3 (± 1.0) 9.0 (± 0.6) N = 3	28.9 (± 1.3) 8.7 (± 1.7) N = 4	32.8 (± 0) 12.5 (± 0) N = 1
Spring, 2002	Ganaraska	16.0 (± 1.6) 1.5 (± 0.4) N = 17	23.2 (± 1.5) 4.2 (± 0.7) N = 86	27.3 (± 1.7) 7.1 (± 1.4) N = 103	28.1 (± 2.4) 8.0 (± 2.5) N = 5	28.9 (± 0.5) 8.1 (± 0.2) N = 2	
Spring, 2003	Ganaraska	17.0 (± 1.3) 1.9 (± .8) N = 39	22.8 (± 1.7) 4.3 (± 1.0) N = 116	27.2 (± 2.0) 6.5 (± 1.3) N = 23	25.4 (± 2.2) 5.8 (± 1.7) N = 48		
Spring, 2004	Ganaraska	15.6 (± 3.3) 1.6 (± 1.0) N = 3	23.7 (± 1.7) 4.8 (± 1.0) N = 103	27.2 (± 2.1) 7.1 (± 1.5) N = 96	28.4 (± 1.5) 8.1 (± 1.1) N = 7	30.2 (± .8) 8.8 (± .6) N =4	
Spring, 2005	Ganaraska	17.3 (± 1.8) 2.0 (± .6) N = 66	22.7 (± 2.2) 4.1 (± 1.2) N = 37	26.4 (± 1.7) 6.2 (± 1.2) N = 186	27.7 (± 2.0) 7.1 (± 1.6) N = 50		32.6 (± 2.0) 10.3 (± .6) N = 2

Table 12. Population estimates for chinook, coho and steelhead salmon returning to the Root River during fall, 1996 through spring, 2005. Fall steelhead are mostly skamania, but may include other strains.

Year	Species	Number of marked fish	Number of recaptured fish	Number of marked fish in recapture sample	Population size (±) 1 SD
Fall, 1996	Chinook	5,440	37	36	5,587 ± 147
	Coho	3,940	9	9	3,940 ± 0
	Fall steelhead	105	29	0	3,150 ± 2,189
Spring, 1997	Chambers Creek	900	38	6	5,014 ± 1,606
	Ganaraska	139	23	5	5,356 ± 1,753
Fall, 1997	Chinook	3,974	40	31	5,127 ± 436
	Coho	6,909	52	45	7,983 ± 436
	Fall steelhead	228	16	2	1,297 ± 509
Spring,1998	Chambers Creek	93	15	2	501 ± 226
	Ganaraska	217	17	1	1,962 ± 1,067
Fall, 1998	Chinook	3,845	55	51	4,146 ± 156
	Coho	3,336	25	19	4,389 ± 493
	Fall steelhead	64	33	1	1,088 ± 609
	Brown	202	31	11	539 ± 118
Spring, 1999	Chambers Creek	678	-	-	-
	Ganaraska	1,043	-	-	-
Fall, 1999	Chinook	5,381	18	7	13,836 ± 4,088
	Coho	978	111	35	3,101 ± 434
	Fall steelhead	19	13	0	266 ± 181
	Brown	125	17	2	750 ± 342
Spring, 2000	Chambers Creek	460	1	0	-
	Ganaraska	1,006	21	13	1,625 ± 278
Fall, 2000	Chinook	6,965	72	13	38,575 ± 9,685
	Coho	2,921	38	11	10,091 ± 2,565
	Fall steelhead	59	16	6	157 ± 51
	Brown	241	22	1	2,771 ± 1,529
Spring, 2001	Chambers Creek	128	8	2	384 ± 157
	Ganaraska	475	27	6	2,137 ± 769
Fall, 2001	Chinook	9,697	142	82	16,792 ± 1,205
	Coho	942	2	1	1,413 ± 471
	Fall steelhead	175	40	3	1,794 ± 762
	Brown	176	71	1	6,336 ± 3,607
Spring, 2002	Chambers Creek	564	15	9	940 ± 198
	Ganaraska	372	14	9	579 ± 115
Fall, 2002	Chinook	9,912	178	143	12,338 ± 458
	Coho	2,079	109	38	5,963 ± 781
	Fall Steelhead	48	5	3	72 ± 19
	Brown	291	11	6	534 ± 147
Spring, 2003	Chambers Creek	185	8	7	211 ± 28
	Ganaraska	497	19	11	858 ± 168
Fall, 2003	Chinook	149	6	5	179 ± 33
	Coho	126	4	3	168 ± 48
	Fall steelhead	6	23	0	144 ± 100
	Brown	53	25	2	663 ± 449
Spring, 2004	Chambers Creek	350	20	7	1,000 ± 305
	Ganaraska	421	32	5	2,694 ± 1,107
Fall, 2004	Chinook	378	11	10	416 ± 40
	Coho	1,148	4	1	2,870 ± 1,284
	Fall steelhead	77	4	3	96 ± 19
	Brown	28	9	0	280 ± 188
Spring, 2005	Chambers Creek	224	7	6	261 ± 40
	Ganaraska	388	9	7	499 ± 89

Figure 1. Steelhead mean length-at-age at the Root River Steelhead Facility during 1995 to 2005. Skamania data from 2001 - 2004 were taken from fish transported and held at Kettle Moraine Springs Hatchery.

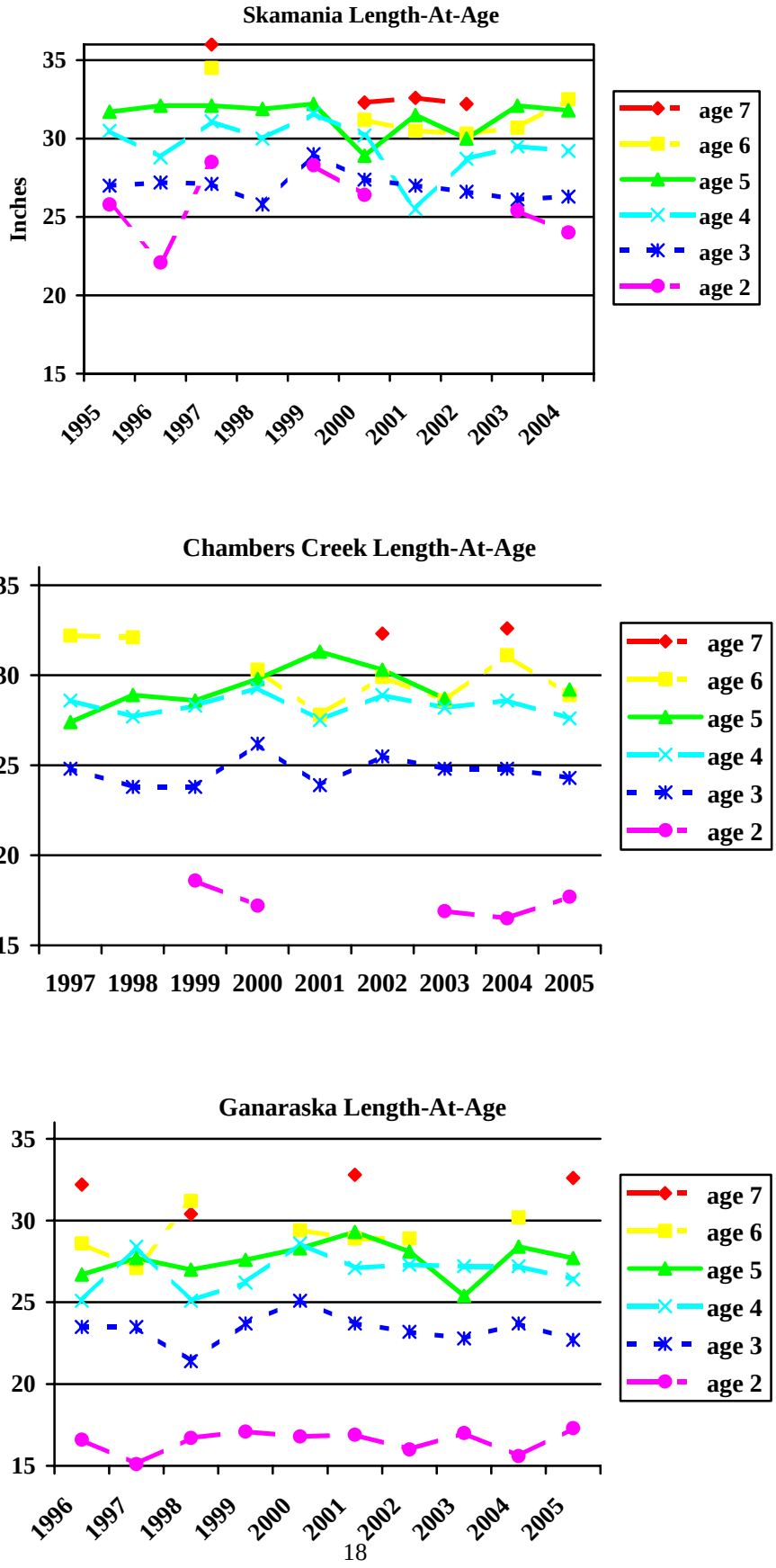
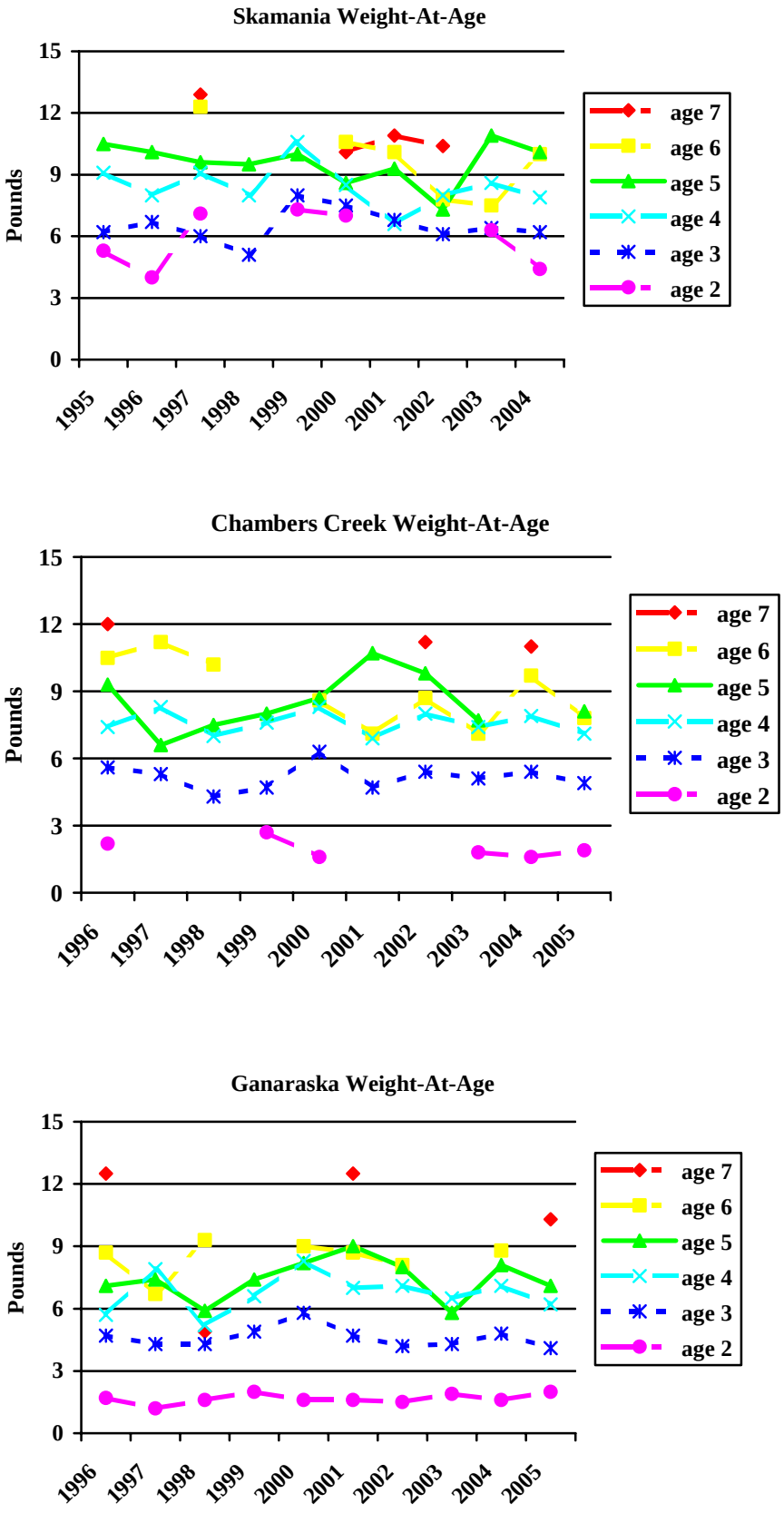


Figure 2. Steelhead mean weight-at-age at the Root River Steelhead Facility during 1994 to 2004. Skamania data from 2001- 2003 were taken from fish transported and held at Kettle Moraine Springs Hatchery.



APPENDIX A. ROOT RIVER STOCKING NUMBERS

Table A-1. Number of fingerling chinook salmon stocked in the Root River during 1994 - 2004. Targets were 169,500, reduced to 143,900 after 1998. Chinook salmon were marked with an oral dose of Oxytetracycline (OTC) during 2001.

Year stocked	Total number	Strain	Fin clip
1994	75,533	Lake Michigan	LP
	60,000	Lake Michigan	None
1995	99,000	Lake Michigan	RP
	69,250	Lake Michigan	None
1996	158,000	Lake Michigan	None
1997	142,500	Lake Michigan	None
1998	161,500	Lake Michigan	None
1999	143,100	Lake Michigan	None
2000	142,900	Lake Michigan	None
2001	143,973	Lake Michigan	None (OTC)
2002	140,280	Lake Michigan	None
2003	143,935	Lake Michigan	None
2004	143,900	Lake Michigan	None

Table A-2. Number of coho salmon stocked in the Root River during 1994 – 2004. Targets were 40,600 spring yearlings and 10,000 fall fingerings.

Year stocked	Total number	Strain	Fin clip	Age
1994	66,080	Lake Ontario	None	Spring yearling 1+
	55,954	Lake Ontario	RMLP	Fall fingerling 0+
	50,389	Lake Michigan	RP	Spring yearling 1+
1995	65,100	Lake Michigan	RMRP	Spring yearling 1+
	54,832	Lake Michigan	RMLV	Fall fingerling 0+
1996	40,590	Lake Michigan	RMRV	Spring yearling 1+
	63,697	Lake Michigan	LP	Fall fingerling 0+
1997	48,107	Lake Michigan	RP	Spring yearling 1+
	6,668	Lake Michigan	REL	Spring yearling 1+
	4,208	Lake Michigan	None	Spring yearling 1+
	20,604	Lake Michigan	None	Fall fingerling 0+
1998	33,666	Lake Michigan	None	Spring yearling 1+
	10,000	Lake Michigan	None	Fall fingerling 0+
1999	45,945	Lake Michigan	None	Spring yearling 1+
	13,824	Lake Michigan	None	Fall fingerling 0+
2000	41,375	Lake Michigan	None	Spring yearling 1+
	10,030	Lake Michigan	None	Fall fingerling 0+
2001	27,970	Lake Michigan	None	Spring yearling 1+
	11,080	Lake Michigan	A-CWT	Spring yearling 1+
	10,260	Lake Michigan	None	Fall fingerling 0+
2002	29,954	Lake Michigan	None	Spring yearling 1+
	10,648	Lake Michigan	A-CWT	Spring yearling 1+
	12,285	Lake Michigan	None	Fall fingerling 0+
2003	31,514	Lake Michigan	None	Spring yearling 1+
	10,845	Lake Michigan	A-CWT	Spring Yearling 1+
2004	40,623	Lake Michigan	None	Spring yearling 1+
	14,500	Lake Ontario	None	Fall fingerling 0+

Table A-3. Number of steelhead stocked in the Root River during 1994 – 2004. Stocking targets were 35,000 per strain, reduced to 27,000 chambers creek and ganaraska after 1998.

Year stocked	Total number	Strain	Fin clip
1994	30,417	Skamania	RM
	35,124	Chambers Creek	LM
	34,759	Ganaraska	LV
1995	37,347	Skamania	ARM
	37,819	Chambers Creek	ALM
	34,494	Ganaraska	ALV
1996	34,254	Skamania	RM
	34,579	Chambers Creek	LM
	35,404	Ganaraska	ARV
1997	35,262	Skamania	RMRV
	35,024	Chambers Creek	LMLV
	35,201	Ganaraska	BV
1998	37,484	Skamania	ARM
	33,187	Chambers Creek	ALM
	33,548	Ganaraska	ALV
1999	35,528	Skamania	RM
	26,951	Chambers Creek	LM
	26,963	Ganaraska	ARV
2000	37,010	Skamania	RMRV
	27,287	Chambers Creek	LMLV
	27,118	Ganaraska	BV
2001	35,247	Skamania	ARM
	27,060	Chambers Creek	ALM
	27,100	Ganaraska	ALV
2002	33,634	Skamania	RM
	27,064	Chambers Creek	LM
	27,125	Ganaraska	ARV
2003	35,448	Skamania	RMRV
	27,123	Chambers Creek	LMLV
	27,150	Ganaraska	BV
2004	35,145	Skamania	RM
	31,039	Chambers Creek	LM
	27,881	Ganaraska	ALV

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